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A Homodyne Receiver For Obtaining Bearings On Drift Buoys

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The University of Auckland's Department of Electrical Engineering has for the past 8 months been host to two Chinese Oceanographic Engineers. The purpose of the visitors' residence in New Zealand has been, apart from general aspects of technical/cultural interchange, to develop apparatus for drift buoy experiments in the Yellow Sea and other North China waters. Drift buoys programmed to transmit from built-in crystal clocks and capable of transmitting several watts of power at 6.247 MHz have been built.

As the buoys drift they will be located by crossed bearings obtained from two fixed aerial Adcock direction-finding installations, two hundred or so kilometers apart, on the Chinese mainland. Position data, as the buoys drift, for defining water movement and some telemetering of temperatures, etc., is the main interest.

January 1981

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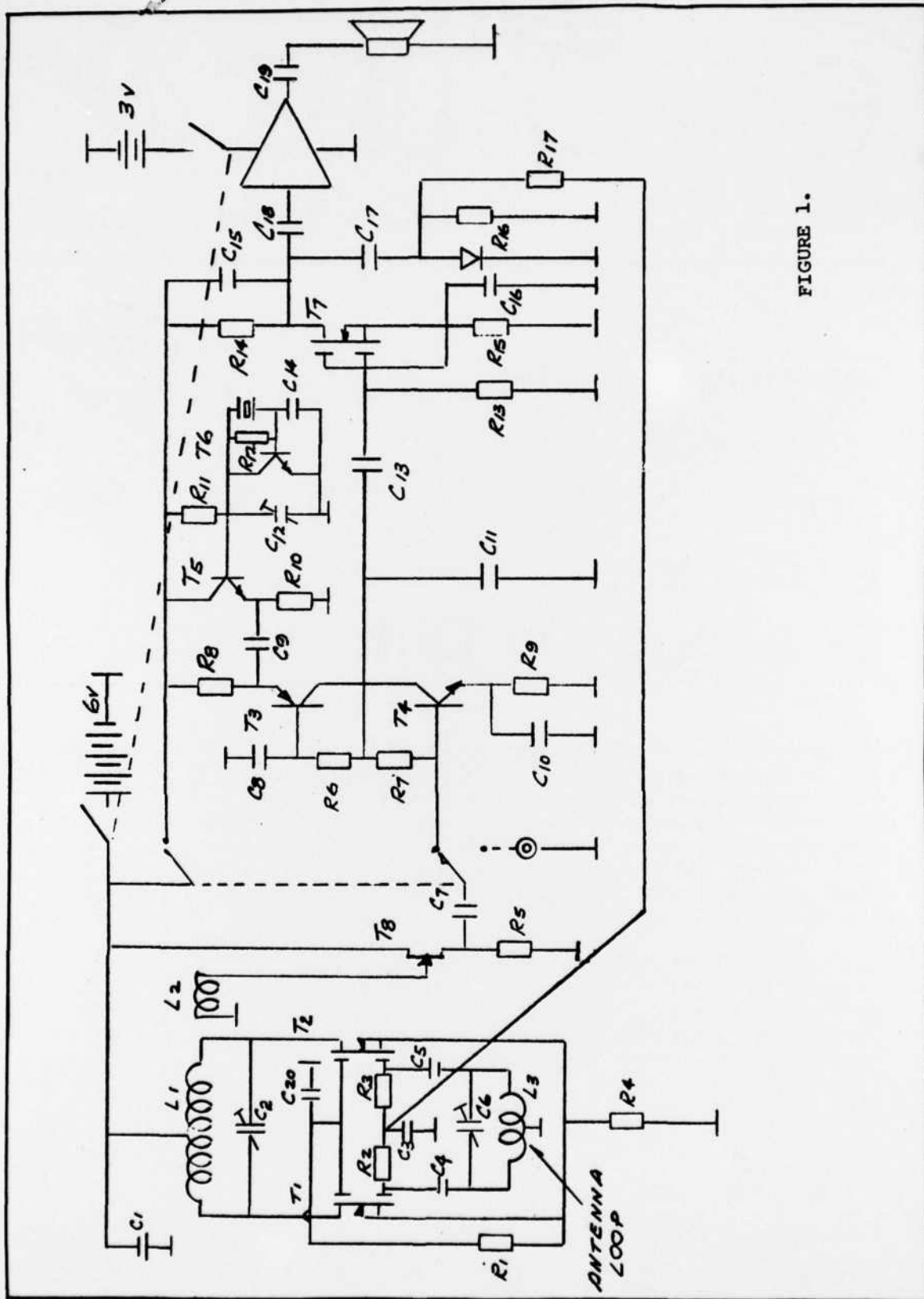


FIGURE 1.

While carrying out tests during the development of the apparatus, a very simple tripod-supported direction finder was developed for use as an auxiliary to the Adcock system. It is the intention of this article to describe this device.

The novelty of the receiver is that it uses the homodyne principle to give a very simple, highly sensitive and adequately selective circuit. The circuit is shown in Figure 1. It can be seen that the output of the balanced loop aerial passes to a mixer where it is heterodyned with a local crystal-controlled oscillator. The frequency of this oscillator is 1000 cycles away from the frequency of the incoming carrier. The audio frequency beat is amplified for the loud speaker.

Drifter buoys of the type used (operating on the international oceanographic frequency of 6.247 MHz) are expected to be received by means of their ground wave signals which are useful over a distance of about 200 miles (Whelan, *et al*, 1975). The transmissions are therefore independent of ionosphere conditions and it is, in fact, found preferable to take bearings on the buoys between the hours of 9 am and 3 pm when conditions for receiving more remote signals are worst. In New Zealand the 6-MHz band is almost silent during these daylight hours so that high selectivity is not needed for receiving the buoy signals. For this reason, the receiver did not incorporate any filtering beyond the simple RC networks shown. Good signals were obtained from a buoy separated by 400 kilometers (over a sea path) from the homodyne receiver.

In order to test whether the conditions in remote New Zealand were unique, the receiver has been tested at a Hong Kong beach site. Here it was also found that the

receiver received no interfering signals during the 9 am to 3 pm period, although beyond these times very many interfering signals transmitted by ionosphere reflection from almost everywhere in Asia could be heard.

The receiver is built in a small aluminum box which includes batteries and a loudspeaker and to which the loop is fixed. The box turns with the loop when a null is being obtained. The loop is made of a circle of aluminum 14-cm in diameter and 6-cm wide. The circle is incomplete for half a centimeter at the top. Around the aluminum band four turns of screened cable are wound. This coil is center tapped at the bottom and ground connections are made to the screening of each turn here. At the top of the loop, where the aluminum band is interrupted, interruptions are also made in the screen of each turn so that no short circuiting turns exist. The null for good signals is very sharp and there is no difficulty in obtaining bearings accurate to plus and minus half a degree with the direction finder.

The noise level of the receiver is the equivalent of about 1 microvolt at the input.

It is intended to use the buoys at distances beyond the ground wave range of 200 miles. In these cases, the Adcock direction finders with their vertical aeriels and consequent immunity from the horizontal component of ionosphere reflected waves will be necessary. Owing to the frequent low level of those signals, and the interference received with them, it will be preferable to use the Adcock and goniometer method of obtaining bearings rather than the recently developed direct phase comparison methods which are possible when clear signals are assured.

Parts List

R ₁	100 K Ω	C ₁	0.1 μ f
R ₂	1 M Ω	C ₂	2-22 pf
R ₃	1 M Ω	C ₃	0.1 μ f
R ₄	510 Ω	C ₄	.01 μ f
R ₅	8.2 K Ω	C ₅	.01 μ f
R ₆	6.8 M Ω	C ₆	2-22 pf
R ₇	8.2 M Ω	C ₇	.01 μ f
R ₈	3.9 K Ω *	C ₈	.01 μ f
R ₉	3.9 K Ω *	C ₉	.01 μ f
R ₁₀	5.6 K Ω	C ₁₀	.2 μ f
R ₁₁	2.7 K Ω	C ₁₁	1500 pf
R ₁₂	1 M Ω	C ₁₂	2-22 pf
R ₁₃	10 M Ω	C ₁₃	330 pf
R ₁₄	3.3 K Ω	C ₁₄	220 pf
R ₁₅	1 K Ω	C ₁₅	0.1 μ f
R ₁₆	100 K Ω	C ₁₆	1 μ f
R ₁₇	1 M Ω	C ₁₇	.01 μ f
		C ₁₈	10 μ f
		C ₁₉	100 μ f
		C ₂₀	.01 μ f

L ₁	32 Turn Central Tapped
L ₂	30 Turn Central Tapped
L ₃	4 Turn Central Tapped 14 cm Diameter

T ₁	> 40841
T ₂	
T ₃	BC214B
T ₄	BC549
T ₅	BC184B
T ₆	BC189B
T ₇	40841
T ₈	2N5459

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Propeller Rotation Direction Circuit

We wished to study the characteristics of a propeller when a progressive wave was passing over it. As part of this study we needed to simultaneously record the propeller speed, its direction of rotation, and the wave profile.

A very simple circuit was designed that functioned to help measure the propeller's angular position and its direction of rotation.

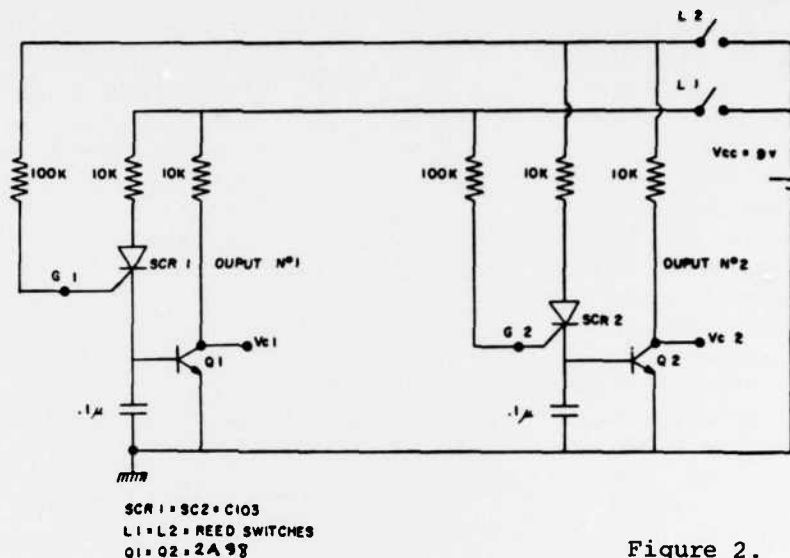
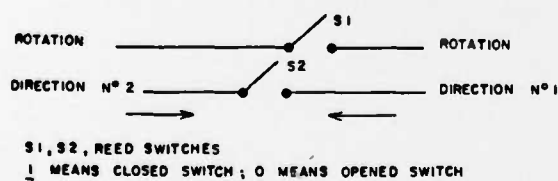


Figure 2.

Four radial magnets were attached to the propeller. For our application, it was fully verified that the magnets did not modify the original mechanical propeller characteristics. Two reed switches were placed on the propeller support elements so that when a magnet passed near them the switches closed and opened almost at the same time. The switch closures followed two different sequences depending on the propeller's direction of rotation (Figure 1).



STEP	ROTATION N° 1		ROTATION N° 2	
	S1	S2	S1	S2
A	0	0	0	0
B	1	0	0	1
C	1	1	1	1
D	0	1	1	0

Figure 1.

When the rotation direction No. 1 is applied, the operation of the circuit, depicted in Figure 2, may be described in the following terms.

- Step A: S1 and S2 opened, then $V_{c1} = V_{c2} = 0 \text{ V}$
- Step B: S1 closed and S2 opened, then $V_{c1} = V_{cc}$; $V_{c2} = 0 \text{ V}$; and $V_{g2} = V_{cc}$
- Step C: S1 and S2 closed, then Q1 and Q2 are saturated; $V_{c1} = V_{c2} = V_{ce}$ (saturation) = 0.3 V
- Step D: S1 opened and S2 closed, then $V_{c1} = 0$; $V_{c2} = 0.3 \text{ V}$ because SCR2 is still conducting. With the other rotation direction (No. 2) similar considerations apply.

Output signals are shown in Figure 3. Rotation direction No. 1 gave a pulse of amplitude $V_{c1} = V_{cc}$ on output No. 1, and a small amplitude pulse ($V_{ce(sat)}$) on output No. 2. Equivalent signals occurred for rotation direction No. 2. Placing a diode between the output and load, $V_{ce(sat)}$ can be avoided if desired.

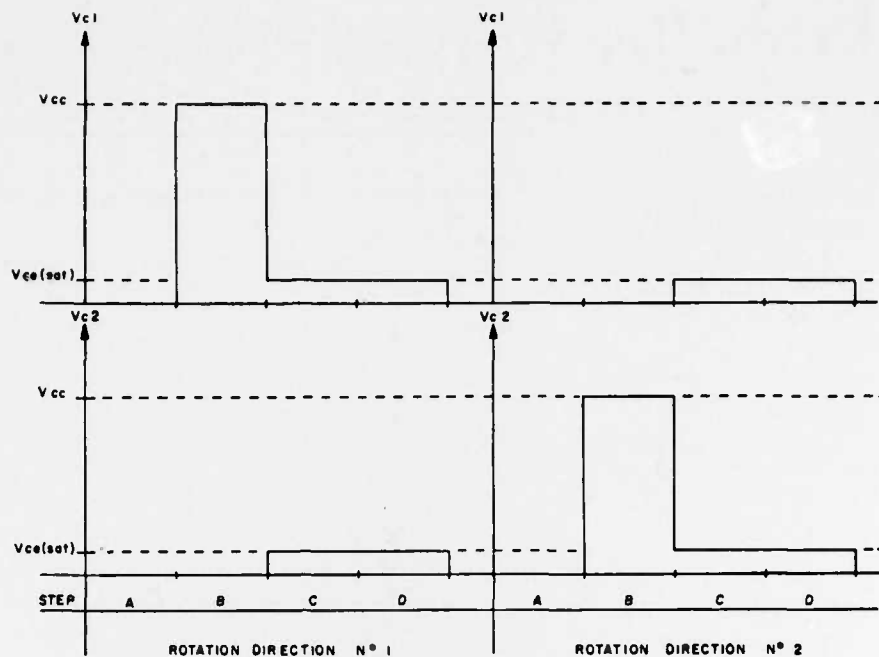


Figure 3.

Output signals with a clock signal are recorded on different channels of a chart recorder.

With time intervals between pulses generated by this circuit, clock period, and the propeller calibration curve, we can compute propeller speed. Propeller rotation direction is resolved by noting on which channel the pulses are recorded.

To process a great amount of data, it would be desirable to determine speed and rotational direction digitally. A microprocessor would perhaps be the most suitable solution to achieve this.

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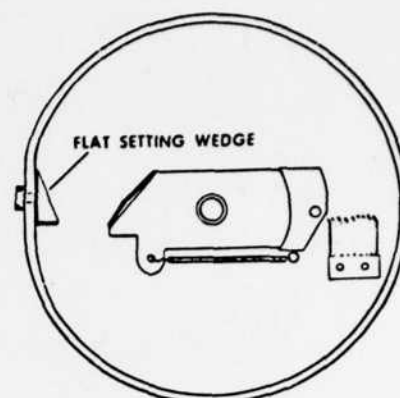


Daniel Valladares, a junior technician, has worked in the Naval Hydrographic Service of the Argentinian Navy since 1978. He is involved with current meter development.

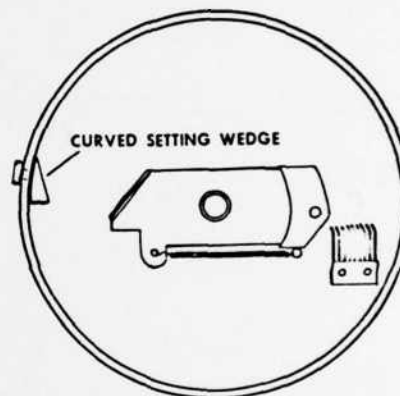
Encoder Cap Deformation in the Aanderaa RCM-5 Current Meter

In a recent attempt to determine the cause of premature battery failure in the Aanderaa RCM-5 current meters used by the U.S. Naval Oceanographic Office, a simple battery life test was performed using several Aanderaa current meters powered by different commercially available batteries designed for this instrument. The meters were set to the shortest sample interval of 30 seconds and placed in a cold room at 0°C with the intent of monitoring the battery voltage versus samples recorded. One day after the start of the test, two of the instruments had noticeable tape transport problems. They ceased to function completely during the second day and the problem was apparently independent of the battery type. As a result, each meter was closely examined with the following results.

It was determined that the "setting wedge" on the inside surface of the plastic encoder cap was rubbing against the outside surface of the encoder in each of the meters that had failed (see Figure 1). This increase in friction resulted in an increased power consumption and the unexpected premature failure of the test meters. Upon examination of the encoder cap, a deformation of the plastic was found at the point where the setting wedge is attached to the inside surface of the cap (see Figure 1a). This deformation



(a) Deformed encoder cap



(b) Non-deformed encoder cap

FIGURE 1 Inside view of an Aanderaa encoder cap

appeared as a flattening of the plastic rim against the outside edge of the setting wedge. This wedge edge is flat rather than curved to conform with the curvature of the encoder cap. Examination of new replacement encoders revealed that this outside edge of the setting wedge has subsequently been modified by the manufacturer to conform with the curvature of the encoder cap (see Figure 1b). The overall diameter of the encoder caps has been increased by approximately one millimeter.

To avoid the expense of replacing the encoder cap to solve this problem, it is possible to apply a small amount of heat to the deformed surface to return it to its original curvature and then, while the cap is still warm, replace only the setting wedge with a new curved wedge rather than one with a flat outside edge. The cap will then hold its curvature and should allow the clearance necessary to avoid dragging in the encoder.

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